Space Weather Technical Forecast

Issued on Friday, 08 December 2023 at 01:07 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-Class flares (R1-R2 Blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is currently Low, peaking at 07/2057 UTC with a C8.2 flare from AR3513, which remains the most active region on the disc with the greatest magnetic complexity. Two moderately large sunspots in the southwest, AR3510 and AR3511, are part of a complex of groups in this area, with magnetic connection between these regions, and AR3511 has produced some lower level C-class flares. AR3507 in the northwest has more of a north-south magnetic alignment, perhaps increasing instability. The other regions on the disc appear mostly smaller and simpler at present.
A number of CMEs have been evident in coronagraph imagery during the past 24 hours. Although none are currently deemed to have any Earth-directed component, further imagery and analysis is required to confirm this.

Solar Wind / Geomagnetic Activity: Solar winds as measured by ACE and DSCOVR at L1 show an ongoing but waning High Speed Stream (HSS) from coronal hole CH76/-. Wind speeds were elevated, initially around 560km/s but declined to slightly elevated levels, ending the period around 460 km/s. Density was predominantly below average, but increased to average levels late in the day. The Interplanetary Magnetic Field (IMF), Bt, has been weak throughout at 5nT or below. The north-south component of the IMF (Bz), has varied weakly. Phi angle has been predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux was predominantly at moderate levels, but very briefly reached High levels, peaking at 1064 pfu at 07/1625 UTC. The associated 24-hour fluence has remained below the Active threshold (1e8 integrated pfu), but with a gradual upward trend. The observation at 08/0000 UTC was 4.056e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate with a chance of isolated M-class flares, mainly from AR3513, but perhaps also from AR3511.

Solar Wind / Geomagnetic Activity: No Earth directed CMEs currently feature in the forecast. Solar winds are currently at slightly elevated levels (around 490 km/s) due to waning effects from a coronal hole HSS. Solar winds are expected to continue to gradually decline through the coming days, remaining mainly slightly elevated today then reaching background levels during tomorrow (9th). Then perhaps later tomorrow, or more likely through day 3 (10th), the high speed stream (HSS) from a new coronal hole is expected to arrive, with speeds increasing to, or close to elevated levels. The HSS influence then declines later day 4 (11th).

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Geomagnetic activity is expected to be largely Quiet with a chance of isolated Unsettled intervals until later tomorrow, or early day 3, when the arrival of a coronal hole HSS should bring Unsettled to Active (Kp 3-4) periods with a slight chance of a G1/Minor Geomagnetic Storm interval (Kp 5). Activity is expected to decline back to Quiet levels (Kp 1-2) through day 4.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is forecast to remain at background levels, with just a very slight chance of reaching the S1/Minor Storm level should there be any larger flares from the sunspot regions in the western hemisphere.
Electron flux is currently at moderate levels. An increase in electron flux, reaching high levels at the diurnal maxima is likely until the expected arrival of the HSS from a coronal hole results in a temporary suppression in electron counts. Through day 4 (11th) the flux is likely to reach High levels at the peak of the diurnal cycle again. The associated 24 hour electron fluence is expected to continue to gradually increase today and tomorrow, but is unlikely to exceed the Active (1e8 integrated pfu) threshold. The fluence is expected to decline through day 3 (10th) but then show an upward turn through day 4 (11th).

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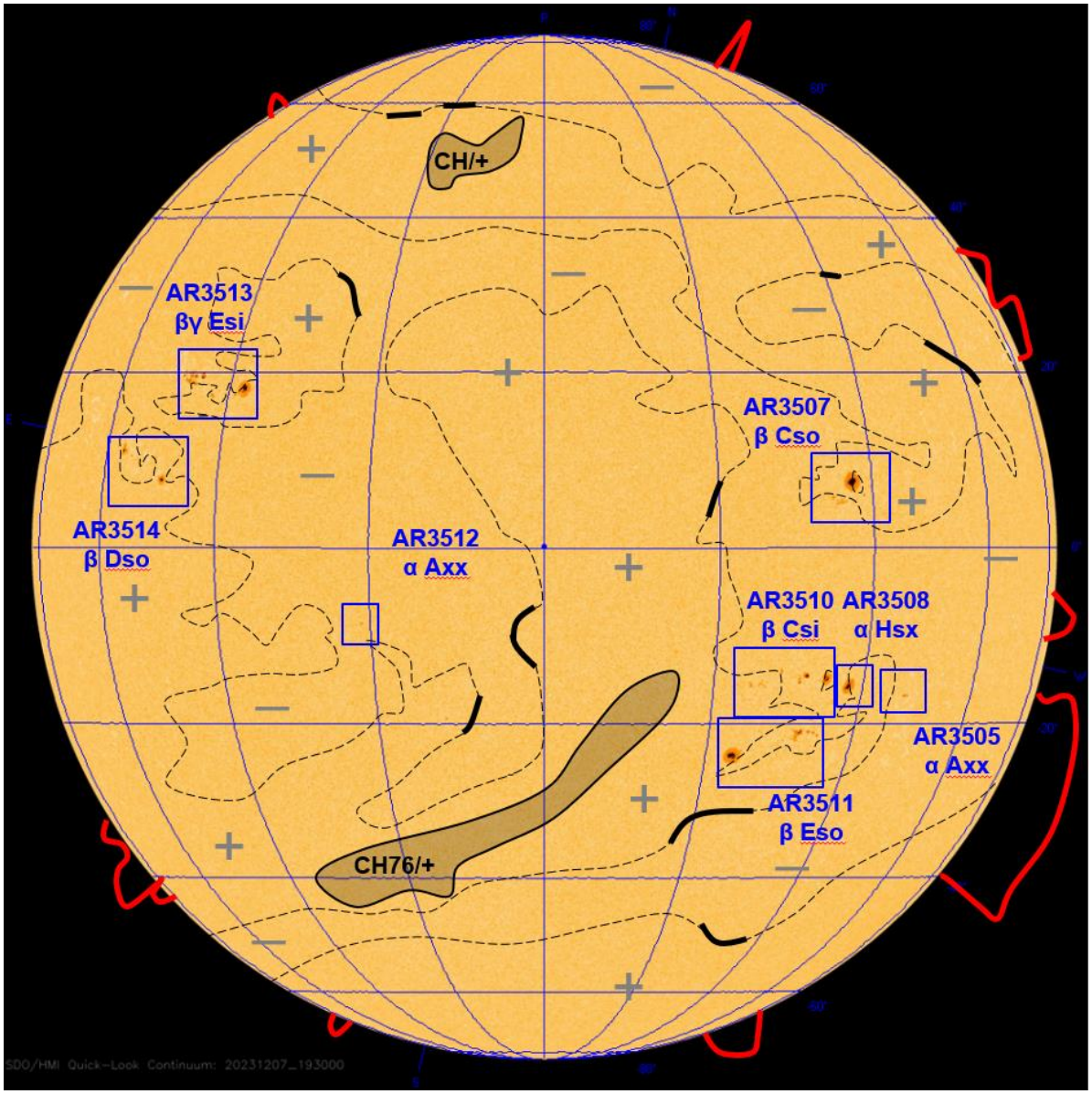
Figure 1. Solar Analysis Valid 07/1930 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There have been various filament eruptions on the Earth-facing disc in the past several days, one of which took place around 07/0200 UTC from the northeasr quadrant. Coronagraph imagery indicates that a CME resulted from this, emerging to the northeast in LASCO C2 imagery around 07/0300 UTC. Further CME's have been visible in imagery, but currently none are expected to be Earth directed, although there is a very light chance of weak glancing blows during days 3 and 4 (10th and 11th).

Solar winds are currently at slightly elevated levels (around 460 km/s) due to waning effects from CH76/-. Solar winds are expected to continue to gradually decline through the coming days, remaining mainly slightly elevated today then reaching background levels during tomorrow (9th). Then perhaps later tomorrow, or more likely through day 3 (10th), the high speed stream (HSS) from a new coronal hole is expected to arrive, with speeds increasing to, or close to elevated levels. The HSS influence then declines later day 4 (11th).

Geomagnetic activity is expected to be largely Quiet with a chance of isolated Unsettled intervals until later tomorrow, or early day 3, when the arrival of a coronal hole HSS should bring Unsettled to Active (Kp 3-4) periods with a slight chance of a G1/Minor Geomagnetic Storm interval (Kp 5). Activity is expected to decline back to Quiet levels (Kp 1-2) through day 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Enlil with no definite CME arrivals.

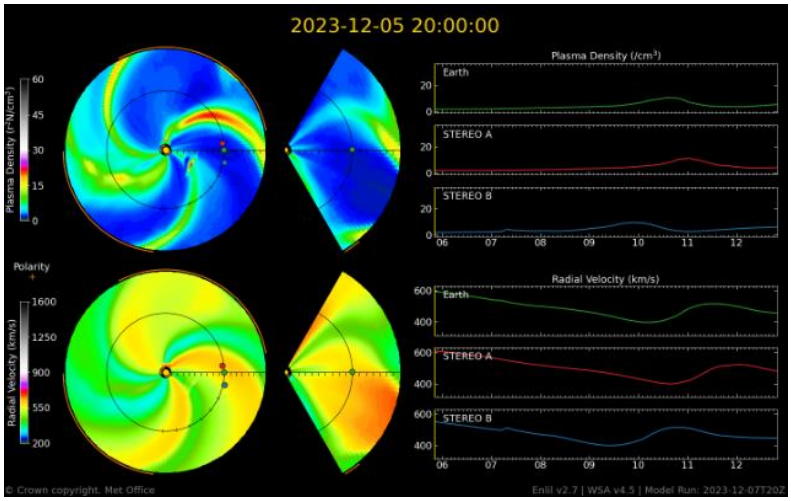

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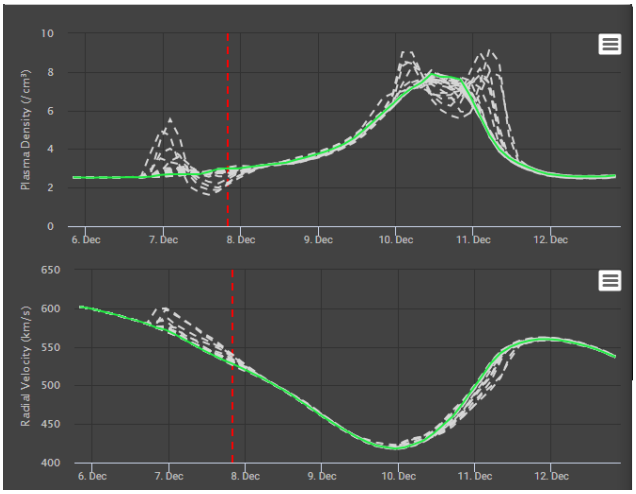
Figure 3: MOSWOC Enlil ensembles indicating a chance of slight glancing blows later in the period.



Radio Blackouts - X-Ray Flares:

There are currently eight sunspot regions on the visible disc. The most active region on the disc is AR3513 in the northeast, which has increased slightly in spot number and area. AR3513 is currently classified as Eso/Beta-Gamma, but because of the increase in weak penumbra on the trailing spots a weak Mount Wilson delta spot is close to developing. Two moderately large sunspots in the southwest, AR3510 and AR3511, are part of a complex of groups in this area, with magnetic connection between these regions. The spots have continued to gradually spread longitudinally, with a recent slight increase in spot number for AR3511. AR3507 in the northwest has more of a north-south magnetic alignment, perhaps increasing instability. The remaining regions on the disc are smaller, magnetically simpler and weaker, with AR3512 barely visible. A new or returning region is likely to rotate onto the southeast limb during the forecast period, perhaps increasing the probability of significant flares.

Solar activity is currently Low with the largest flare of the past 24 hours a C8.2 at 07/2057 UTC, which originated from AR3513. Low to Moderate activity is expected with a chance of isolated M-flares, mainly from AR3513, but perhaps also from AR3511.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

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The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels and is most likely to remain so in the next few days. There is a slight chance of S1/Minor Storm conditions being reached should any significant flares occur, mainly from AR3510 and AR3511 as they rotate further across the western disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux is currently at moderate levels. An increase in electron flux, reaching high levels at the diurnal maxima is likely until the expected arrival of the HSS, either late tomorrow (9th) or early day 3 (10th) from a coronal hole HSS resulting in a temporary suppression of electron counts. Through day 4 (11th) the flux is likely to reach High levels at the peak of the diurnal cycle again.
The associated 24 hour electron fluence is expected to continue to gradually increase today and tomorrow, but is unlikely to exceed the Active (1e8 integrated pfu) threshold. The fluence is expected to decline through day 3 (10th) but then show an upward turn through day 4 (11th). REFM is considered to be providing reasonable guidance, keeping the fluence below the Active threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	40	40	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: MOSWOC REFM model.

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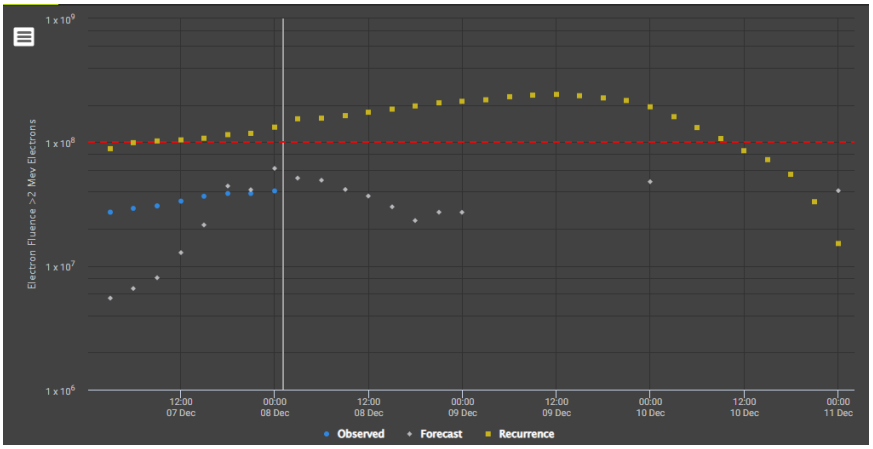

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